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PACKAGING PERFORMANCE TESTING
OF A
SINGLE WALL, GRADE 275, CORRUGATED FIBERBOARD BOX, (16 IN
BY 16 IN BY 16 IN), CONTAINING SIXTEEN 1-QUART ROUND METAL
CONETOP CANS - PACKING GROUP I (SURFACE MODES ONLY)

AFPTEF PROJECT NUMBER: 99-109
POP TEST ID NUMBER: DODPOPHM/USA/DOD/AF69/TR99006

Part 1. Report Cover

TEST REPORT APPLICABILITY STATEMENTS see section 2E:

Manhours: 24 Hours

Report Prepared by: _____

Susan J. Misra
Materials Engineer

A. Report Number: DODPOPHM/AF69/TR99006

B. Title:

SINGLE WALL, GRADE 275, CORRUGATED FIBERBOARD BOX, (16 IN. BY 16 IN. BY 16 IN.), CONTAINING SIXTEEN 1-QUART ROUND METAL CONETOP CANS - PACKING GROUP I (SURFACE MODES ONLY)

Responsible Individual: Michael Werneke

This report has been approved for publication and dated:

Approved by:

L.A. WOOD, Chief
Engineering Branch

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Acting Chief, AF Packaging Technology
and Engineering Facility

Performing Activity:

AF Packaging Technology and Engineering Facility
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AFPTEF Reference: 99-109

Date: 19 July 99

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Specific Authority:

Distribution Statement F. Further dissemination only as directed by the Air Force Packaging Technology and Engineering Facility (AFPTEF), AFMC LSO/LOP, 5215 Thurlow St, WPAFB OH 45433 or higher DoD authority.

Requesting Organization: Defense Logistics Agency
DDC-TO
ATTN: Linda McCarthy
2001 mission Drive
New Cumberland PA 17070

Requesting Organization's Reference(s):

- (1) Letter 1 Oct 98
- (2) Memorandum, DOSO-DO, 15 Oct 98, MIPR to accomplish POP Testing.

Part 2. Data Sheet**A. Exterior Shipping Container****UN Type:** FIBERBOARD BOX**UN Code:** 4G**NSN:** N/A**Specification Number(s):** ASTM D5118, Style RSC,/ASTM D4727, Type CF,
Class DOM, VAR SW, GR 275**Container Manufacturer:** A.S.A.P. (Allied Shipping and Packaging),
Dayton, Ohio**Date of Manufacture:** April 1997**Material:** Corrugated Fiberboard**Container Dimensions:** 16 in. x 16 in. x 16 in. ID**Closure (Type/Method):** ASTM D1974, Sealing Method B (7-Strip Method),
Use 2-inch A-A- 1830 Clear Tape on closure.**Reinforcement (Type/Method):** Use 1-inch Filament Reinforced Tape IAW A-
A-1687, 2 Girthwise Bands (3-inches from each end) encircling top, bottom and
sides, reinforcement method 2B and 3 horizontal bands (3-inches from the top
and bottom and one centered) encircling the ends and sides.**Closure Specification Number(s):** A-A-1830 Clear Tape, 2-inch**Reinforcement Specification Number(s):** A-A-1687 Fiber Reinforced Tape,
1-inch**Absorbent Material Description:** Vermiculite, Fine Grain, Palmetto
Vermiculite Company, Incorporated, Grade C-3**Additional Description:** N/R**B. Inner Packaging of Combination Packaging****Type:** Round Metal Conetop Can**NSN:** N/A**Manufacturer/Distributor:** Consolidated Plastics Co., Inc.**Date of Manufacture:** N/R**Manufacturer's Number(s):** 41944LG**Capacity:** 1-Quart (32-ounces)**Dimensions:** 3 1/4-in. diameter x 8 3/4-in.**Closure (Method/Type):** Metal Cap and Fiber Reinforced Tape**Secondary Closure (Method/Type):** A-A-1687, Fiber Reinforced Tape,
1-inch**Additional Description:** N/A**C. Actual Product:** Not Used**D. Test Product:** Used**Name:** Water**United Nations Packaging Group:** I**Physical State:** Liquid**Amount per outer container:** 16**Test Weight:** 58.9 lb. (26.7 Kg)**Density/Specific Gravity:** 1.0**Drop Height:** 1.8 Meters**Stacking Weight/Force:** 362.4 lb. (164.7 Kg)**Additional Description:**

1. Line the box with a 4 Mil Polyethylene gusseted bag, size 23 in. x 17 in. x 46 in.
2. Place 3-in. of vermiculite absorbent in bottom of box. Place 16 cans (4 rows of 4 cans) on vermiculite. Center bottles in box and fill with vermiculite. Cover with 4-in. of vermiculite.
3. Shake down and add vermiculite to make a tight pack.
4. Twist bag and tape closed with fiber reinforced tape.
5. Closure IAW 2a.

E. Test Applicability- See test results in parts 7

(1) Tests documented herein are design qualification. It is the responsibility of the government shipper/certifier to fully verify design compliance and packaging material quality.

(2) Drop testing performed herein was tested in accordance with DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This joint DoD policy document allows packaging to be drop tested more than once provided the packaging continues to pass the 49CFR 178.603 requirements. Questions about or clarification of this policy can be sought from the respective preparing activities of the regulation.

(3) DoD contractor use of this test report or its resultant certifying mark only with the permission of the testing activity AND as specified in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A.

(4) Pass/fail conclusions were based on the particular specimens, both inner and outer containers, and quantities of each submitted for test. Extrapolation to other manufacturers, applications, commodities, inner containers, container sizes, or lesser internal quantities is the responsibility of the packaging design agency or applicable higher headquarters and the limitations documented in 49CFR. Extrapolation of test results based on lesser than minimum UN/DoT required test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

(5) Reference to specification materials has been made based on one of the following methods: supplied by AFPTEF, provided by the requester, markings printed on, attached to or embossed on the packaging.

(6) Testing performed in accordance with 49CFR 170-180, except as documented in this report.

(7) Performance testing was undertaken and completed at the request of an agency responsible for management of the dangerous good(s). The completion of successful UN/DoT testing does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

(8) The DoT performance tests are intended to evaluate the performance of the entire packaging configuration's ability to prevent the release of contents during conditions normally incident to transportation. The criteria used to evaluate container system performance is whether the contents of the packaging are retained intact. The successful completion of the recommended tests does not ensure undamaged delivery.

(9) Tests performed and documented, herein, in no way verify Government supplier's operations (included but not limited to: internal procedures, suppliers, or manufacturing processes) comply with the DoT's or international's regulations. The testing facility has no knowledge and assumes no knowledge, that specific material testing requirements (i.e. plastics - only allowed to use regrind from the same operation; specific vendor plastic formulations including quantity of carbon black, ultra-violet inhibitors or pigments, or production run's individual leakproofness tests) are or were performed by the manufacturer(s) listed herein, unless otherwise noted in the report.

Part 3 Introduction.

Brief description of why specific tests were performed and rational for the test product selected (if applicable).

The equivalent of Packing Group I testing was requested on the above stated configuration. This configuration is intended to be applicable to a large

assortment of liquid products contained in metal cans. For lesser volumes, variations to testing requirements can be found in 49 CFR, part 178.601(g).

Water was used as test liquid as permitted by 49 CFR part 178.602(c).

A secondary closure utilizing 1-inch, filament reinforced tape was applied to the cans IAW accepted packaging practice.

The corrugated fiberboard box was sealed using 2-in. clear tape on joints. The box was additionally reinforced with 5 strips of 1-in. filament reinforced tape around the box: Two girthwise bands around the box top, bottom and sides, approximately 3-inches from each end. Three horizontal bands encircling the ends and sides, approximately 3-inches from the top and bottom and one centered.

One combination packaging was subjected to drop and vibration testing as prescribed by ASTM D4919. These tests are designed to simulate the shock and vibration a package configuration may encounter during conditions normally incident to transportation. The order of testing was drop, static loading test, followed by vibration testing.

In conducting the drop testing, all five drops were performed on the same box. The decision to use the same container for all five drops was directed by DLA/DOSO and based on the relatively minimal damage demonstrated during previous similar testing of fiberboard containers, i.e. historical experience with these containers. Five drops per box exceeds 49 CFR part 178.603 requirements as well as both the UN and ASTM recommendations. The use of one configuration for multiple tests and drops is DoD policy as stated in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A.

Part 4. Tests Required/Performed:

A. Drop test - 5 drops - Top, Bottom, Long and Short side, Top corner (fiberboard- manufacturer's joint)
The drop height shall be appropriate for the packaging group of the commodity. See part 6.
The container shall strike the target which shall be a rigid, non-resilient, flat, and horizontal surface.
For other than flat drops, the center of gravity shall be vertically over the point of impact.

NOTE 1: Fiberboard boxes shall be conditioned for a minimum 24 hours prior to testing. Standard conditions $23 \pm 3^{\circ}\text{C}$ ($73 \pm 4^{\circ}\text{F}$) and $50 \pm 2\%$ relative humidity apply.

B. Stacking test - One test per container, 3 containers required.
Compression by a top load is calculated to simulate a stack height of 3 meters, maintained for 24 hours, followed by testing the containers stability by placing two loaded containers on top of the tested container for at least 1 hour.

NOTE 2: Where the contents of the test sample are non-dangerous liquids with relative density different from that of the liquid to be transported, the force shall be calculated in relation to the latter.

NOTE 3: Fiberboard boxes and packages fabricated from fiberboard, paperboard, or paper including composite containers with outer fiberboard containers, should be conditioned for a minimum 24 hours prior to testing. Standard conditions $23 \pm 3^{\circ}\text{C}$ ($73 \pm 4^{\circ}\text{F}$) and $50 \pm 2\%$ relative humidity apply.

C. Vibration Test (Domestic requirement). One test per container, total of three test specimens.

The test shall be performed for 1 hour at a frequency that causes the package to be raised from the vibrating platform to such a degree that a piece of material approximately **0.2 cm (1/16 in.)** thickness can be passed between the bottom of the package and the platform. The vibrating platform shall have a vertical double-amplitude (peak-to-peak) displacement of **2.54 cm (1 in.)**. Perform tests in accordance to 49CFR 173 Subpart B, Appendix C and 49 CFR 178.

MATERIAL SPECIFIC TEST

D. Fiberboard (Water resistance test) - One test per fiberboard specimen, total of six. Strong, solid or double faced corrugated fiberboard (single or multi-walled) must be used, appropriate for the capacity and the intended use of the box. The water resistant outer surface must not increase in mass greater than **155 grams per meter² (0.0316 pounds per foot²)** after 30 minutes in accordance with International Standards Organization (ISO) 535 or Technical Association of the Pulp and Paper Industry (TAPPI) T441 or ASTM D3285. Three individual fiberboard specimens shall be exposed on the wire side and another three on the felt side.

Part 5. Applicable Packing Group Test Requirements:

A. Drop Test.

1. Solids and liquids, if the test is performed with the actual contents to be carried, or with another substance having essentially the same characteristics, or for liquids if the test is performed with water and the intended contents has density less than 1.2 g/cm³ (specific gravity less than 1.2) the drop height shall be:

<u>Packing Group</u>	<u>Drop Height</u>
I	1.8m (70.9 inches)
II	1.2m (47.2 inches)
III	0.8m (31.5 inches)

2. Where the test sample doesn't contain the intended contents and its specific gravity is greater than 1.2, then obtain the required drop height in meters by calculating the following with product density (d):

<u>Packing Group</u>	<u>Drop Height</u>
I	(d) x 1.5m ((d) x 59.1 in.)
II	(d) x 1.0m ((d) x 39.4 in.)
III	(d) x 0.67m ((d) x 26.4 in.)

Round the drop height up to the first decimal.

B. Stacking Test.

Static weight. Apply the calculated weights using a constant load evenly over the entire container.

$$M = \frac{m (3000-h)}{h}$$

where: m = container's gross mass (as shipped) in kilograms
h = container's height in millimeters
M = constant load mass in kilograms

or:

$$W = \frac{w (118-h)}{h}$$

where: w = container's gross weight (as shipped) in pounds
h = container's height in inches
W = constant load weight in pounds

Information - This test assumes similar weight containers stacked on top of the test sample. This may or may not be a valid assumption. This calculation also only provides a minimum weight. Consideration should be given to what will actually be experienced in the transportation cycle.

Part 6. Criteria for Passing Tests:**A. Drop test.**

Each packaging containing liquids shall be leakproof when internal and external pressures are equalized. Composite and combination containers shall not exhibit damage to the outer packaging likely to adversely affect transportation. In addition, the inner packaging shall not leak the filling substance or lading.

B. Stacking test.

No test sample shall leak. Composite and combination containers shall not exhibit leakage of the filling substance from the inner receptacle or container. No test sample shall show deterioration which adversely affects transportation safety or show any distortion liable to reduce its strength, cause stacking instability, or cause damage to internal container components likely to reduce transportation safety. When employing a dynamic compression tester, a container passes if after application of the required load for the specified time, there is no buckling of the sidewalls sufficient to cause damage to the contents; in no case shall the maximum deflection exceed 1-inch.

C. Vibration test.

No rupture or leakage from any of the packages. No test specimen shall show any deterioration which could adversely affect transportation safety, result in possible discharge of contents or reduce packaging strength.

D. Fiberboard (water resistance test).

The calculated water absorption of all samples shall be less than 155 g/m².

Part 7. Discussion and Test results:**Narrative description of test results, including any rationale for variations.****A. Drop test.****Pass**

Tested at standard conditions: 23 Degrees C., 50% RH.
One combination packaging (sixteen 1-quart round metal conetop cans in a grade 275 corrugated fiberboard box) was dropped 1.8 meters onto the required four flat sides and the bottom manufacturer's joint. There was minimal damage to the cans, but no leakage from the cans. Except for minor crushing of the impacted area, no adverse results were noted. This test procedure of five drops with one container exceeds the 49 CFR requirements, see part 3 for detailed discussion of this DoD deviation.

B. Stacking test.**Pass**

Duration: 72 Hours at standard conditions: 23 Degrees C., 50% RH.
The same combination package used in the drop tests was also used for the stack test. One combination packaging (sixteen 1-quart round metal conetop cans in a grade 275 corrugated fiberboard box) was stacked with 362.4 lb. for 72 hours. There was no additional damage to the cans and no leakage from the cans. No adverse results were noted. This test procedure of 72-hours with one container exceeds the 49 CFR requirements.

C. Vibration test.**Pass**

Duration: 3 Hours at standard conditions: 23 Degrees C., 50% RH.
The same combination package used in the drop tests and stack test was also used for the vibration test. One combination packaging (sixteen 1-quart round metal conetop cans in a grade 275 corrugated fiberboard box) was tested on an electro-hydraulic vibration table which was set at 1-inch vertical double amplitude (peak-to-peak) displacement, at a frequency such that the box was raised from the platform. The distance was measured using a 1/16-inch feeler gage. At the proper frequency the feeler gage could be passed between the

bottom of the package and the table surface. There was no additional damage to the box or cans and no leakage from the cans. Except for minor crushing of the impacted area, no adverse results were noted. This test procedure 3-hours with one container exceeds the 49 CFR requirements.

D. Water resistance (Cobb method) test. Pass

Test at standard conditions: 23 Degrees C., 50% RH.
As required by 49 CFR part 178.516, the COBB Method Test for water absorptiveness was performed on specimens cut from the lot of boxes used in the drop stack and vibration tests.

3 Specimens were tested on the exterior side. Average **120.9 g/m²**.

Values : **121.0 g/m², 120.6 g/m², 121.1 g/m²**

3 Specimens were tested on the interior side. Average **117.9 g/m²**.

Values : **116.8 g/m², 120.9 g/m², 115.9 g/m²**

0 Specimens exceeded the 155 grams per square meter maximum limit.

Many factors may affect water absorption by corrugated fiberboard. Among these factors are abrasion, wear, flexure, improper storage, and age. These can greatly decrease the ability of the fiberboard to resist water absorption and result in higher than tested results. In addition, some fiberboard products are only treated on one side of the material, making the box construction method of increased importance. Usually, the water resistant side is the smooth side. The shipper must take appropriate steps to ensure that the box is correctly constructed with the water resistant side on the outside.

For container to pass all applicable tests must be performed and pass criteria listed herein.

Part 8. Marking on Container:

The container specified herein passes the DoT and international regulatory requirements to the extent tested. Equivalent DoD built or grandfathered containers MAY also qualify for the following marking as directed by DoD policy documents.

UN 4G/X26.7/S/99
USA/DOD

Part 9. References

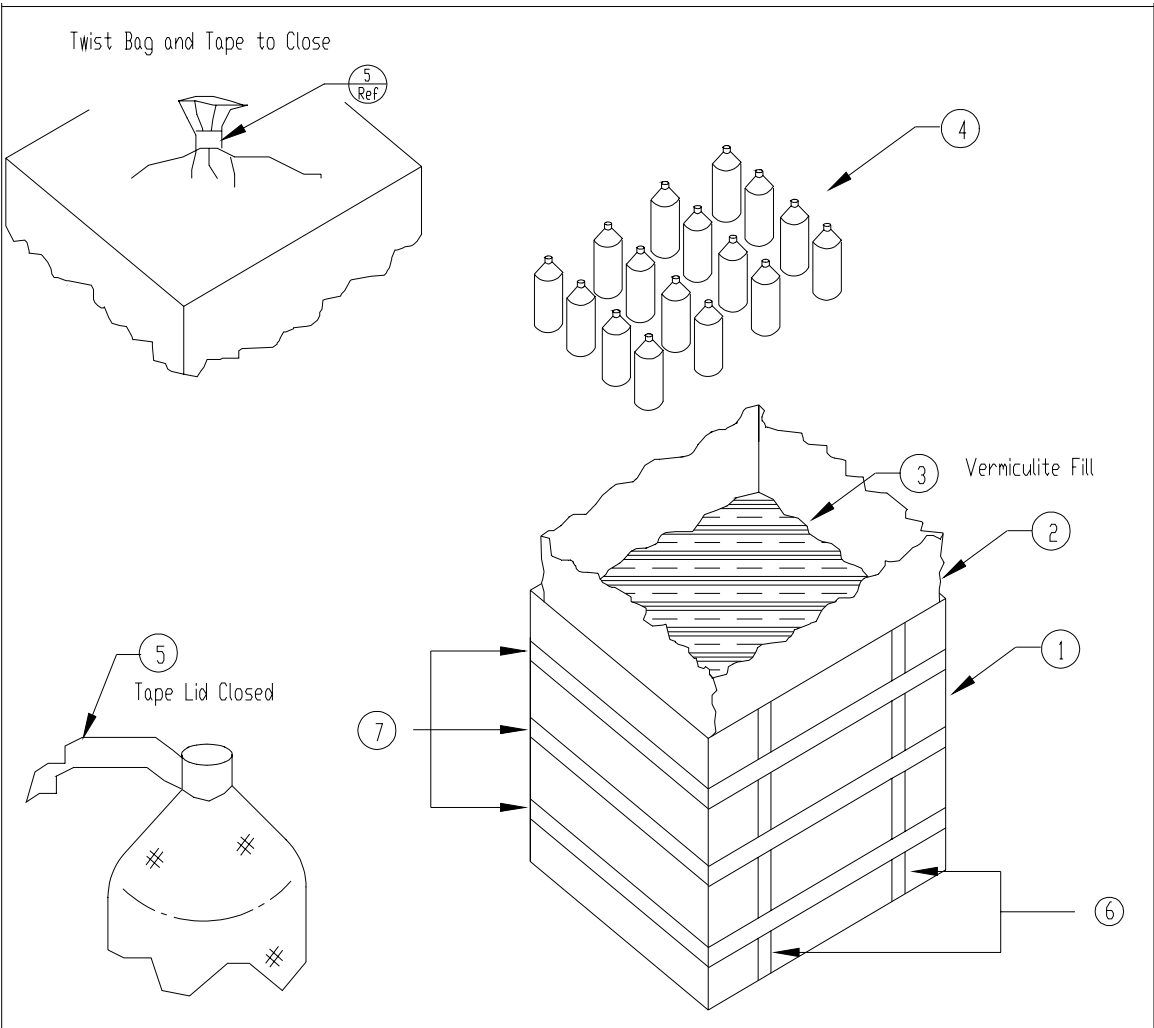
- A.** 49CFR 170-180
- B.** DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55A/MCO 4030.40A - Packaging of Hazardous Materials
- C.** ISO 535/TAPPI T 441/ASTM 3285 - Determination of Water Absorption of Paper and Board (Cobb Method)
- D.** ISO 3574 - Cold-reduced carbon steel sheet of commercial and drawing quantities.
- E.** ASTM D999 - Methods for Vibration Testing of Shipping Containers.



Sixteen 1-Quart Round Conetop Metal Cans To Be Placed Inside A 16-in. x 16-in. x 16-in. Fiberboard Box as A Combination Package.



Combination Package Containing Sixteen 1-Quart Round Conetop Metal Cans. Outer container is reinforced with five strips of fiber reinforced tape.



8			
7	A/R	Horizontal Bands, Fiber Tape	
6	A/R	Girthwise Bands, Fiber Tape	
5	A/R	Fiber Tape	
4	16	Inner Containers, 1-Quart	
3	A/R	Vermiculite	
2	1	Poly Bag	
1	1	Single Wall Corrugated Fiberboard Box	
Item	Qty	Description	Notes
		AFPTF Air Force Packaging Technology and Engineering Facility	Note: Follow All Instructions in TR
File: TR99006D.DWG			Dimensions in Inches
Dwg No: TR99006D			Scale: NONE
Engineer: SJ Misra		DATE: 19 Jul 99	PAGE 1 OF 1

Part 10. Distribution List

Commander
DDC-TO
Attn: Linda McCarthy
2001 Mission Drive
New Cumberland PA 17070

AFMC LSO/LOP
Project Folder